# Bringing urban food supply closer to food consumption: opportunities for five European metropolitan regions

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## Abstract

Agro-food systems in urban and metropolitan regions are complex structures that simultaneously have to respond to domestic supply, compete on global markets and ensure to consumers a direct relationship with both food producers and production sites. In this regard, the strengthen of the local dimension, through the enhancement of proximity agriculture, is a strategic goal to foster both local resources and improve regional socio-economic viability.

The paper adopts a territorial approach to analyse agro-food systems in five European metropolitan regions. The proposed methodology aims at deepening the actual capacities of urban and peri-urban agriculture in adequately meet urban food demand, its role in the economic dimension of the primary sector, the opportunities for exploiting the local component, as well as at providing preliminary results to be taken into account in order to shape proper regulations in their respective agro-food sector.

## Keywords
Urban food supply, relocalisation, proximity agriculture

## Introduction

Market conditions and trade liberalization have been, since the Nineties, putting more and more pressure on the potential earnings of agricultural producers. Driven by market rules, they have to deal with the most convenient choice, based on comparing their production costs with international market prices; this way, food products are more often transferred from places where the production is cheaper to other ones that ensure more profitable sales. Thus, the increasing dependency on global markets and international trade (Porter et al., 2014) results in a parallel augmentation of the spatial disconnection between production and consumption sites (Pradhan, 2014; Aubry and Kebir, 2013). Such a trend has augmented over time and farming systems in urban areas have primarily adapted to the opportunities offered by market enlargement, rather than meeting urban food demand. Nevertheless,

more recently, a different awareness has been emerging, driven by several motivations that claim for an enhanced local dimension in agro-food systems: the scarce sustainability of long-distance transport of food (Allen and Wilson, 2008), the poor adequacy of global supply in ensuring food security and accessibility (Alexandratos and Bruinsma, 2012), the social function of bringing agricultural production within cities (Hunter and Brown, 2012), the new food equation (Morgan and Sonnino, 2010) and the shift towards demand-driven agro-food systems (De Treville et al., 2004), which underline the key role of consumers and their preferences for local and regional food (Kneafsey et al., 2013). This has been resulting in the emerging of alternative systems characterized by a spatial proximity between producers and consumers, which go under the name of Local Agro-food Systems (Feenstra, 1997; Henderson, 1998; Lacy, 2000; Hinrichs, 2003).

In this perspective, urban food supply should then rely on the productive capacities of proximity agriculture, and on the opportunities in adjusting to consumers' requests and providing enough food to meet demand. The capacity of agricultural systems in complying with food requirements is an aspect of crucial importance, revealing on one hand the ties of the supply-demand pattern with the territory, and on the other the possibility to foster local resources and strengthen economic viability of the territory itself. Any political intervention in the agro-food sector or any food planning initiative intended for this, cannot therefore ignore the actual conditions of the agricultural system. It then derives that preliminary analyses and assessments of the context are essential and need to be based on the investigation of both food supply and demand dimensions: in several occasions it has been deepened the role of urban and peri-urban agriculture in providing food to the city, estimating at what extent they are able to do this. Most of these analyses don't however take into account neither the simultaneous combination of performance indicators, nor aspects related to food supply-demand dynamics.

On these bases, the paper introduces a territorial approach for the analysis of agro-food systems in five European metropolitan regions, which represent the case study areas of the European project FOODMETRES[1]. It proposes the utilization of quantitative elements to express the actual capacities of local agricultural resources in responding to  the challenges of domestic supply, in competing in the global context and in fostering the relocalization of food production and consumption; accordingly, strengths and weaknesses of the systems are returned and serve as indications to shape proper regulations in their respective agro-food sector.

## Method

The research has focused on the analysis of the agricultural systems of five European regions: the metropolitan areas of Berlin, London, Milan, Rotterdam (OECD, 2006) and Ljubljana (Sali et al., 2014), which differ each other for territorial, demographic and productive features (table 1).

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[1] FOODMETRES - Food planning and innovations for sustainable metropolitan regions (FP7-KBBE-2012-6-312185).

Table 1. Overview of case study areas

|  | Area (km$^2$) [a] | Population (Mio. People) | Density (people/km$^2$) | UAA (ha) [b] | UAA (%) [b]/[a] | UAA (ha/pers.) |
|---|---|---|---|---|---|---|
| Berlin | 30,534 | 6.04 | 198 | 1,860,951 | 59 | 0.31 |
| Ljubljana | 20,172 | 2.05 | 102 | 474,432 | 23 | 0.23 |
| London | 16,344 | 15.57 | 970 | 761,384 | 47 | 0.05 |
| Milan | 13,111 | 7.89 | 602 | 489,668 | 37 | 0.06 |
| Rotterdam | 3,056 | 7.84 | 1,168 | 134,160 | 44 | 0.04 |

Source: own elaboration

The proposed methodology is based on the calculation and the combination of quantitative elements that express the current relations between regional food supply and demand in a given territory; in order to evaluate what the territory can actually produce and its capacities in meeting regional food requirements, all the aspects related to food processing and distribution are not taken into account, which means, in other words, operating at staple food level.

*Analysis of demand*

Food consumption data have been used as a proxy for food demand. Consumed amounts expressed by the dietary habits collected in the EFSA database (EFSA, 2011) and in the Slovenian national survey (STAT, 2014), have been back transformed to the correspondent amounts of their p agricultural primary product

$$C_p = \sum_s C_s * ty_s * n$$

(eq. 1)

according to consumptions of food subcategories (s), population (n) and a suitable conversion factor ($ty_s$) that expresses how much of the raw product is contained in the final product.

Afterwards, a further aggregation into the f food groups of *i)* cereals, *ii)* fruit, *iii)* vegetables, *iv)* potatoes, *v)* oil plants, *vi)* wine grape, *vii)* sugar beets, *vii)* milk, *ix)* meat and *x)* eggs, has led to the quantification of their respective food consumptions:

$$C_f = \sum_p C_{p,f}$$

(eq. 2)

*Analysis of supply*

On the supply side, current produced amounts (S) of the same f food group have been quantified starting from data provided by National Agricultural Censuses and FAO statistics:

$$\sum_f S_{p,f} = \sum_{p,f} (a_p * y_p)$$

(eq. 3)

with a the hectares intended for each p primary product and y their respective productive yield, and, for animal products

$$\sum_b S_b = \sum_b S(B) \tag{eq. 4}$$

with the supplied amount of each b animal products depending on the function B that combines animal heads, productivity per head and slaughtering yield.

*Quantitative elements*

Based on the comparison between this latter component and the former dimension, three main quantitative elements have been defined, namely:

- The compliance with food demand ("Quantity index"); in other words, the level of self-sufficiency is estimated, revealing how much the local production pattern fits with local food habits (eq. 1), under the assumption that each p staple food cannot replace one another (eq.2):

$$1 - \frac{\sum_p (C_{p,f} - S_{p,f})}{\sum_p (C_{p,f})} \tag{eq. 5}$$

for any p for which $(C_{p,f} - S_{p,f}) > 0$ (eq. 6)

where $C_{p,f}$ and $S_{p,f}$ represent respectively the consumed and supplied amounts of food or food group.

- The agricultural value at production-level ("Value index"). A simplified economic balance of the metropolitan agro-food system which aims at assessing the opportunities of a territory in generating economic viability. It is obtained by summing all quantities of each raw product multiplied by their respective producer prices ($PP_p$):

$$\frac{\sum_{p,f} (S_{p,f} * PP_{p,f})}{\sum_{p,f} (C_{p,f} * PP_{p,f})} \tag{eq. 7}$$

- The market orientation of food categories (eq. 17). It derives from the comparison between their relative importance on both the supply (eq. 18) and the demand (eq. 19) side, revealing the prevalent orientation to global (MO≥1) or local markets (MO<1):

$$MO = \frac{IRS}{IRD} \tag{eq. 8}$$

with

$$IRS = \frac{\sum_f (S_{p,f} * PP_p)}{\sum_{p,f}(S_{p,f} * PP_p) + \sum_o S_o * PP_o} \tag{eq. 9}$$

$$IRD = \frac{\sum_f (D_{p,f} * PP_p)}{\sum_{p,f} (D_{p,f} * PP_p)} \tag{eq. 10}$$

and o other agricultural activities not related to food production.

The subsequent assessments of urban agricultural systems and their opportunities to reinforce the local and proximate component, is based on the simultaneous analysis between, in first instance, the compliance with food demand and the economic balance, and secondly with the market orientation.

## Results

From the simultaneous analysis of the productive dimension and the economic balance (fig. 1), it emerges the possibility to outline and compare the capacities of agricultural systems in different regions, which in turn peculiarly characterizes their performances. Such a comparison, in fact, evidences the opportunities for the region either to have their food requirements met thanks only to local resources, or its territorial and economic viability strengthened.

This way, a first characterization of local production types intended for food is provided. If on one hand the economic component is a key factor for assessing the vitality of the primary sector in a given area, on the other it has to be considered that the positioning of the whole system rather mainly depends on the variety and amounts of staple foods produced. Very specialized agricultural systems are not in fact able to shape their productions to the variety of commodities demanded by consumers; an economic surplus is associated to an excess of supply: this is what occurs in the Rotterdam area, due to the large amounts of both milk and vegetables. Actually, this is a quite unusual situation for urban and metropolitan areas, in which the value of agricultural production is in general much lower than the value corresponding to the consumption pattern expressed by population.

*Figure 1. Performance of agro-food systems in case study areas*
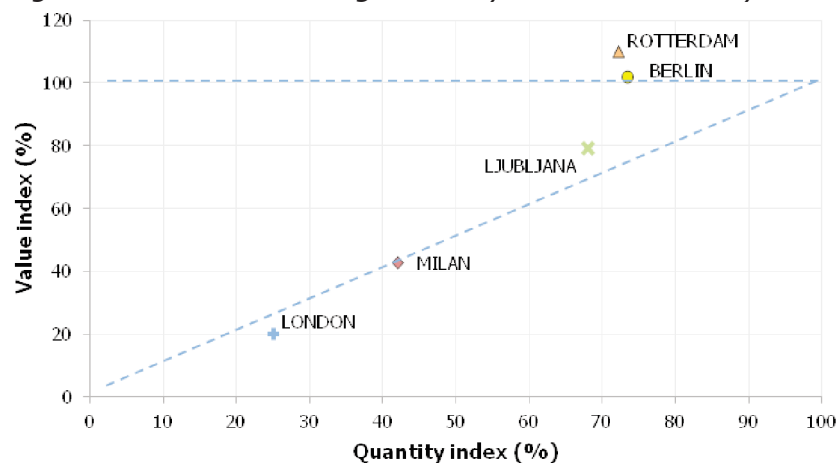


*Source: own elaboration*

Accordingly, the performances of any system is summarized by the ability to provide larger or smaller productions with a higher or lower economic value, resulting in different levels of system productivity and profitability. Indications in this sense are therefore strongly related to the dimension and the specificities of each urban context, leading to different but peculiar results across regions. Since based on the current situation of each agricultural system, they reflect the actual opportunities and differences in spatially reconnecting food supply and demand. The productive capacity and the compliance with food demand provide information about the potentialities of the local urban food provision in adequately meeting local food requirements. Different agricultural systems can in fact variously sustain the demand for food. The urban nature of the metropolitan regions on one hand, and on the other their

specific agro-climatic conditions which favour (or not) the cultivation of specific products (i.e. the specialization of agriculture), affect the possibility of a total compliance with food requirements at both diet and staple food-level (fig. 2). In this perspective, some staple food groups categories are scarcely connected to their respective demand while others, for which the system is self-sufficient, demonstrate to have the strength to compete in global markets; conversely, scarcer capacities reveal the necessity to depend for food on other and wider systems, with an exposure to other than local or regional markets; this indicates the difficulty in achieving a short-distance based food chain. Better, it would be achieved by adopting structural modifications in the agro-food sector, e.g. increasing either the cultivated land extent or the total outputs, with further repercussions on both the economic and the environmental dimension of sustainability.

*Figure 2. Compliance of food production patterns with food demand*
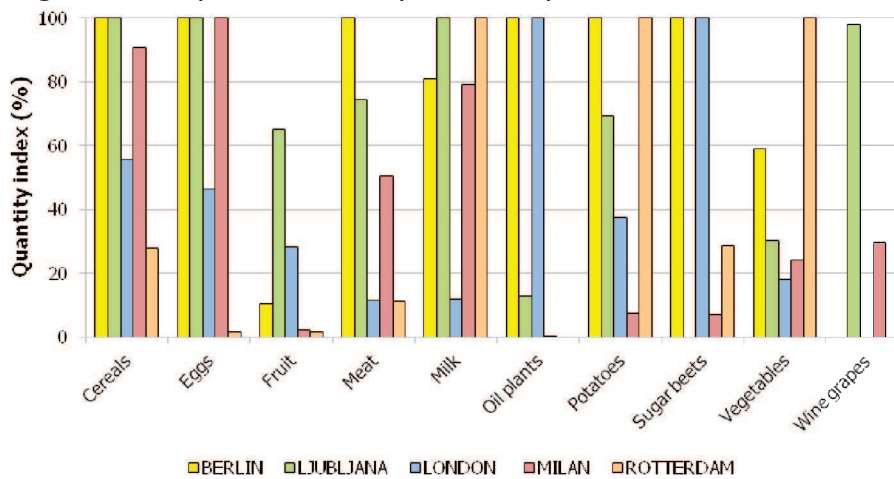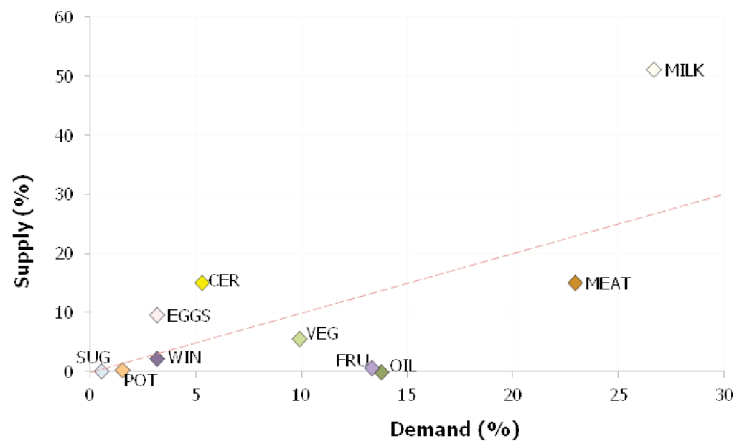


*Source: own elaboration*

Based on a similar approach, the economic balance indicates the position of the food groups on the market, emphasizing their market orientation. The chance to be locally consumed or mainly commercialized on and through more global markets, defined by equation 8, depends in fact on the relative importance of a product in the agricultural production system (equation 9) compared to the role it plays in the local consumption (equation 10). The ratio The relation determines the possibility to distinguish the market propensity of food groups, according to their position with respect to the benchmark represented by the proportional trend between the variables themselves: local or global market orientation, if below or above the benchmark respectively (fig. 3).

This approach enables identifying the most remunerative and economically important productions, not only affected by their farm-gate price but even more deriving from the production pattern. Once again, in fact, the global orientation is strictly linked to an excess of supply, in turn dependent on agriculture specialization. In this way, it is possible identifying food productions that better than others are able to generate value within the territory. In this perspective the respective productive sector may be strengthened, in order to foster both the particular features of the territory and its own resources, enhancing the role of the local component and economic advantages for the area. In this regard, however,

it is to be considered the economic viability of the territory is affected also by the agricultural sector as a whole, including other agricultural activities not related to which can play a key role in the local development and viability.

Figure 3. Market orientation of food products per region. Example of Milan Metropolitan Region



Source: own elaboration

The joint interpretation of both the indicators, allows further defining the production-consumption relation. In general terms, simultaneously analysing the performances of the case study areas under both the productive and economic point of view, a correspondence between the aspects exists; however, some exceptions evidence the peculiarities of the agro-food systems (table 2).

Table 2. Relation between compliance with demand and market orientation. General overview.

| Compliance with demand | Deficit | Surplus | Deficit | Surplus |
|---|---|---|---|---|
| Market orientation | Global | Global | Local | Local |
| Food products (n.) | | | | |
| Cereals | 1 | 3 | 1 | |
| Eggs | 1 | 3 | 1 | |
| Fruit | | | 5 | |
| Meat | 1 | 1 | 3 | |
| Milk | 1 | 2 | 2 | |
| Oil plants | 1 | 2 | 2 | |
| Potatoes | | 3 | 2 | |
| Sugar beets | 1 | 1 | 1 | 2 |
| Vegetables | | 1 | 4 | |
| Wine grape | 1 | | 4 | |
| **Total** | **7** | **16** | **25** | **2** |

Source: own elaboration

On these bases, it is possible to classify all the staple food categories of case study regions. Each group is made of heterogeneous products and agricultural systems here considered here point out typical features of Western agro-food systems: a strong specialization in some

sectors that are highly developed and oriented to global markets and others small in size and targeted at local markets. To a local orientation a productive deficit is associated and this ensures the ties with the territory and the local component. This combination best interprets the connection between production and consumption and the possibility to strengthen regional proximity agriculture and its role in providing enough food to suit consumers' demand. For instance fruit and vegetables (with in this latter case the important exception of Rotterdam), are sectors generally characterized by a local market and an inadequate compliance with demand. In this sense, some common features amongst case study areas must be noted. Despite different territorial contexts, in fact, milk-based and cereals-based products are mostly oriented to global markets, while, on the contrary, meat has a lower export potential. On the other hand, in few cases other sectors (related to cereals, oil plants, potatoes, sugar beets and animal products, respectively) are more oriented to the global market, even in presence of productive deficit. In the Milan area, this apparent inconsistency is to be primarily found in the specialization of the system, and only in second instance in the respective price paid to the producer. Cereals and milk amounts, although insufficient to meet the respective demand, are largely higher than the other food products; this makes sure that, in relation to the total value generated by regional agriculture, it is such to ensure them a prominent economic role.

The lacking correspondence between productive surplus and global markets is not attributable neither to specific products, nor to specific geographic areas; still, as these deviations are rather observed in all case study areas, it derives the systematic nature of this phenomenon, as long as the existence of peculiar features for each individual system. Such a disconnection between production sites and output categories, evidences that the economic dimensions rather seem to depend on the processes food products undergo from production to distribution: the level – or not - of processing and industrialization of some productions affects the whole value generated by the sector in the territory, in terms of both production value and value added. Food processing can in fact contribute in increasing the agricultural value generated in the territory through a further value added, and the economic importance can potentially increase due to this condition. Conversely, more limited amounts of foods to be processed, would scarcely generate further value; it is this the case of animal breeding, layers in particular, for which, however, the large amounts of their respective products are such as to ensure mainly a global market orientation.


**Conclusions**

Agro-food systems in urban and metropolitan regions are complex structures that simultaneously respond to domestic supply, compete on global markets and ensure to consumers a direct relationship with both food producers and production sites.
In this regard, the potentials for a relocation of production-consumption dynamics are pointed out, based on the actual conditions of the considered agricultural systems. This way, they emerge both their peculiar features and the opportunities that arise to exploit these capacities, in order to make the most of their local resources and increasing, through them,

the closeness between production and consumption in the region and its sustainability in general.

In fact, if one hand the spatial reapproaching between primary production and food consumption reflects the adequacy of the productive pattern to the expression of civil society for food, it further emphasizes the role of local resources and their commitment with the regional or the global context. This is of strategic importance for the maintenance of agricultural areas close to cities strengthening peri-urban agriculture, enhancing farms' and system's resilience and fostering the metropolitan agro-food system as a whole. From this point of view, it moreover emerges the possibility to favour the establishment or the further development of local agro-food systems, possibly aimed either at the enhancement of specific products that better meet the urban food demand or at the socio-economic revitalization of the territory. The reinforcement of such initiatives play an important role as a modality to introduce innovative elements in the agro-food system, and as an instrument of local governance that further strengthens the local dimension and regional development.

Moreover, the economic dimension of regional production strictly affects the economic and the territorial viability at regional scale. The local commitment of production value is mostly linked to the variety of regional food products, suggesting that diversified productions would have positive repercussions on the adequacy in meeting food demand. On the other hand, the presence of other agricultural activities not related to food further contributes to the economic viability of the region. Thus, the maintenance and the reinforcement of the primary sector in urban areas would lead to favour positive economic results.

In conclusion, the methodological analysis adopted has served as a key instrument indicating strengths, weaknesses and critical points of the systems themselves, in order to provide indications and sustain interventions in both agricultural and food sector, aimed at strengthening the proximity agriculture and the role of local agricultural systems as a whole. The importance of these results emerges in a political perspective, with stakeholders and/or policy-makers who should take into account these kind of preliminary analyses and considerations before carrying out deeper  assessments or providing interventions, according to their main aim, whether well-being, sustainability or regional socio-economic viability.

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